Measuring Distance and Computing Area

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In the last three issues of *Alabama's TREASURED Forests*, we've featured a series of articles discussing the measurement of direction. These previous articles included factors associated with "North," "Angles of Azimuth and Bearing," and using lines of "Direction" to locate places on a map.

Let's now look at measuring "Distance." A few hundred years ago, the French desired to establish a worldwide standard for all measurements. The purpose was to facilitate trade and price. One such measurement was for distance, the *meter*, on which the *metric system* was based. The meter was defined as one ten-millionth (1/10,000,000) the distance from the North Pole to the Equator as measured in Europe. Even though Napoleon later rejected this system, it finally became the standard for much of the world. Thomas Jefferson wanted to use it for the American standard as well; but this idea failed, primarily because the English standard had already become established among most all the people of the "New World."

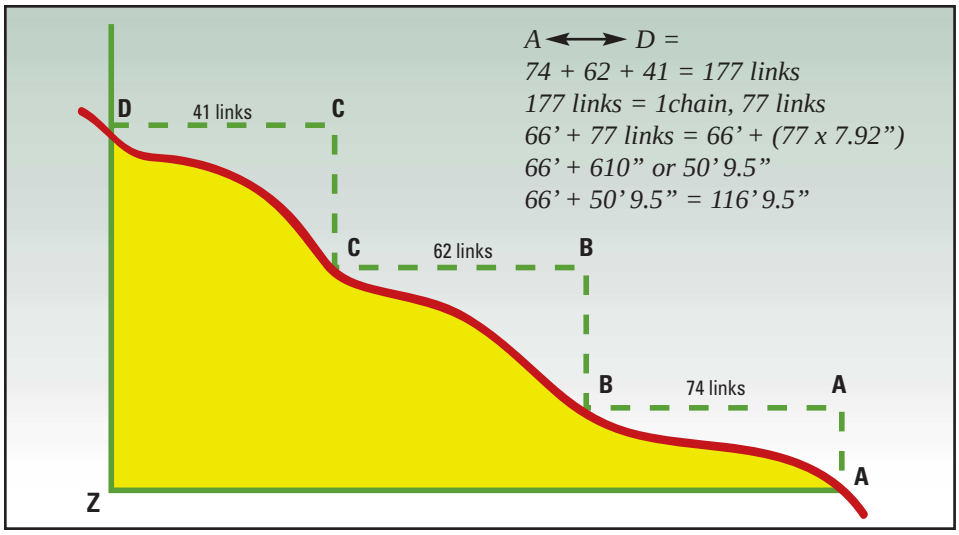

Figure 1 A to Z is the same distance as A to B + B to C + C to D. However, the horizontal distance is shorter than A to D as measured along the surface of the earth. Since the entire length of the chain/tape cannot be used horizontally on the slope, segments called "breaking the chain/tape" are added together.

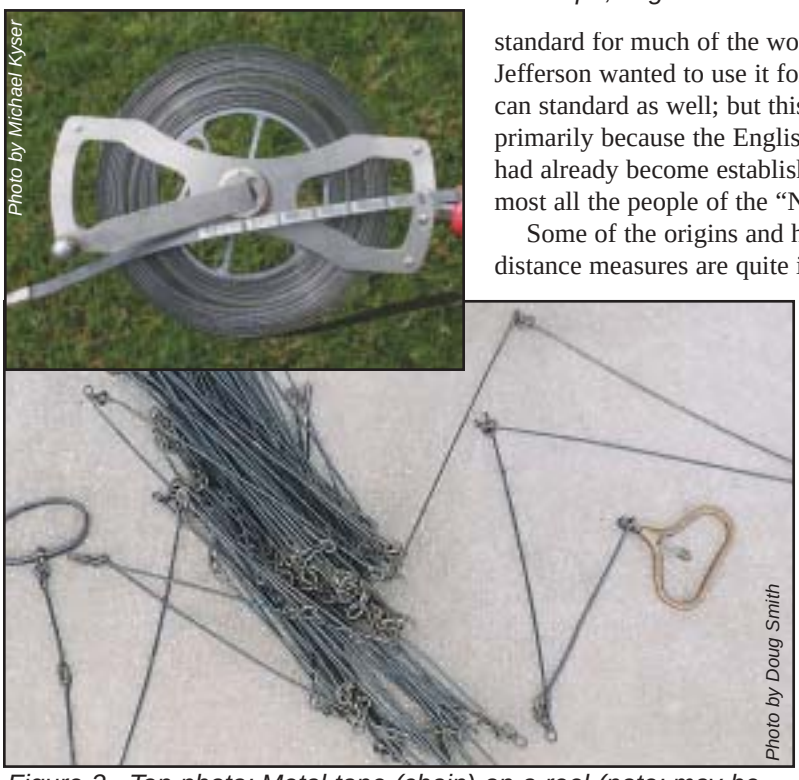
Photo by Michael Kyser

Photo by Doug Smith

Figure 2 Top photo: Metal tape (chain) on a reel (note: may be metal or fabric). A link on one end is graduated and marked with ten divisions for increased accuracy. Bottom photo: Example of a Gunter's Chain. A surveyor's chain = 66 feet = 100 links, therefore one link = .66 feet = 7.92 inches.

Some of the origins and history about distance measures are quite interesting:

- A *cubit* is the distance from the fingertips to the elbow. Noah's Ark was 300 cubits long.
- A *rod* or *pole*, used to drive oxen, was about 16 feet long and was handy for measuring land since it was the longest, usable tool commonly available to a farmer. The length later became an official 16 ½ feet when the British Empire decreed it to be the combined lengths of the left feet of the first 13 men exiting a certain English church on a designated day.
- A *foot* was the length derived from the end of the toe to the rear of the heel of the foot. It probably fell to kings or tribal leaders to declare the standards.
- The *mile* originated from having Roman soldiers march with a step of 2 ½ feet: one mile was declared 1,000 paces or 5,000 feet.
- The *furlong* was defined as the length of one side of a square ten-acre field, or 660 feet. In the 17th century, Queen Elizabeth decreed one mile equal to eight furlongs or 5,280 feet or 320 poles.

Regardless of the units of measurements – be they English, Metric, or other — all distance measurements associated with travel and area determinations must be made on a horizontal plane! Notice in

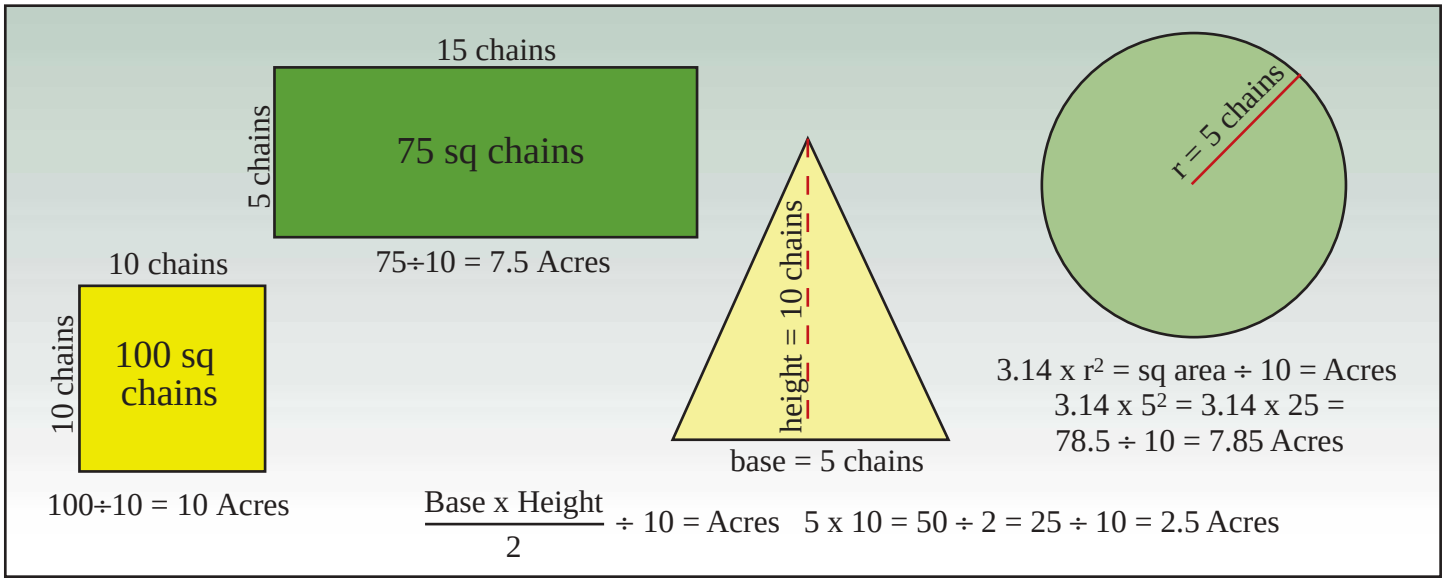

Figure 3

Figure 1 that you may own a lot of surface area on the side of a steep hill but not a relatively equal amount of distance.

The English mathematician, Edmund Gunter, developed a tool to measure distances in lengths that would easily convert to the mile or the acre. He figured that a 66-foot *chain* would not only be an even part of the mile (1/80), but ten square chains would be one acre. By dividing the chain into 100 equal parts or links, the chain became a fairly accurate measuring tool for that period (1600-1800). The linked chain could be folded for convenient storage. Later versions came in the form of a steel tape with the links stamped in the metal. The tape could be rolled on a spool, or with a little training, could be "thrown" into a relatively small circle for storage. Later versions were produced on non-stretchable fabric that was lighter and easier to handle. The steel chain or tape was commonly one chain long in order to stretch it tight on the horizontal. However, two chain lengths were also common for relatively flat terrain. See Figure 2.

Pacing is a rough measurement of distance. Measure a chain on the ground. Walk from one end to the other and count your steps. You can then use this as a field tool that is always available. Averaging your pace of a longer distance and variety of slopes will give you an even better estimate of your individual pace. Start by stepping off with your left foot and count only every other step (each time your right foot strikes the ground). This makes remembering the count much more easy. Frequently check your pace count to ensure accuracy.

If you walk/pace the distance of a chain and your right foot strikes the ground twelve times, then you have twelve paces per chain. Now step 48 paces and you have gone 4 chains. Note that 120 paces will be 10 chains, which is significant because 10 square chains equals one *acre*.

Let's now use our distance knowledge to compute *area* in acres. The following four examples are shown in Figure 3.

a) If you pace a square that is 10 chains long on a side, the figure contains 100 square chains. There are 10 square chains per acre, so divide 100 by 10 to get 10 acres.

b) Suppose your tract of land is a rectangle and you pace or measure a width of 5 chains and a length of 15 chains. The area of a rectangle is L x W, thus 5ch x 15ch equals 75 square chains. Therefore, 75 square chains divided by 10 square chains per acre produces an area of 7.5 acres.

c) What if your property is the shape of a triangle? Pace the base and height, use the formula ½ Base x Height, and divide that by 10 to calculate the acres.

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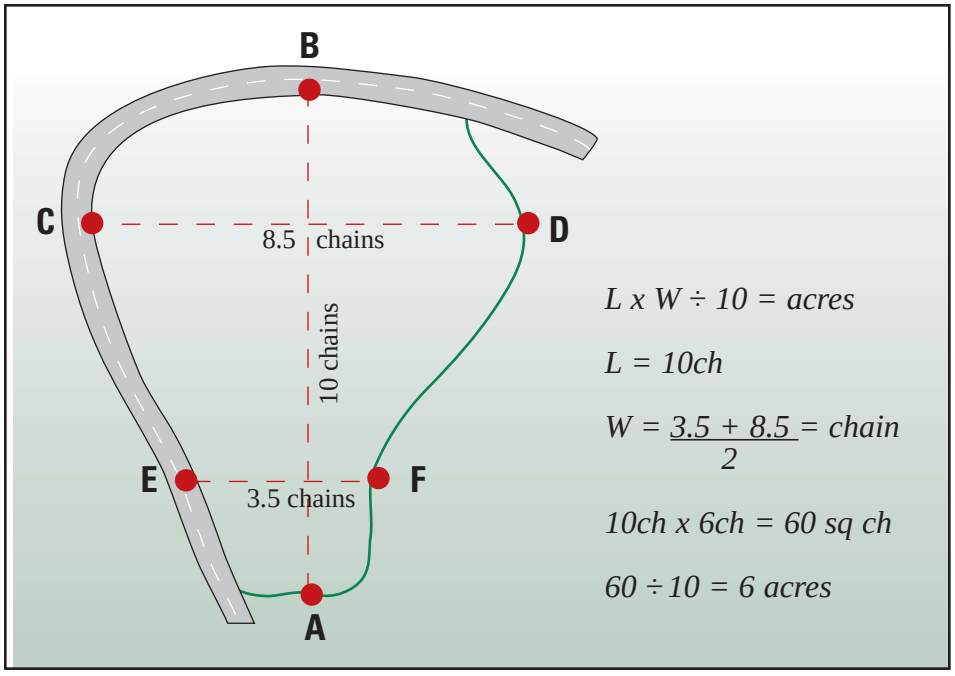

Figure 4

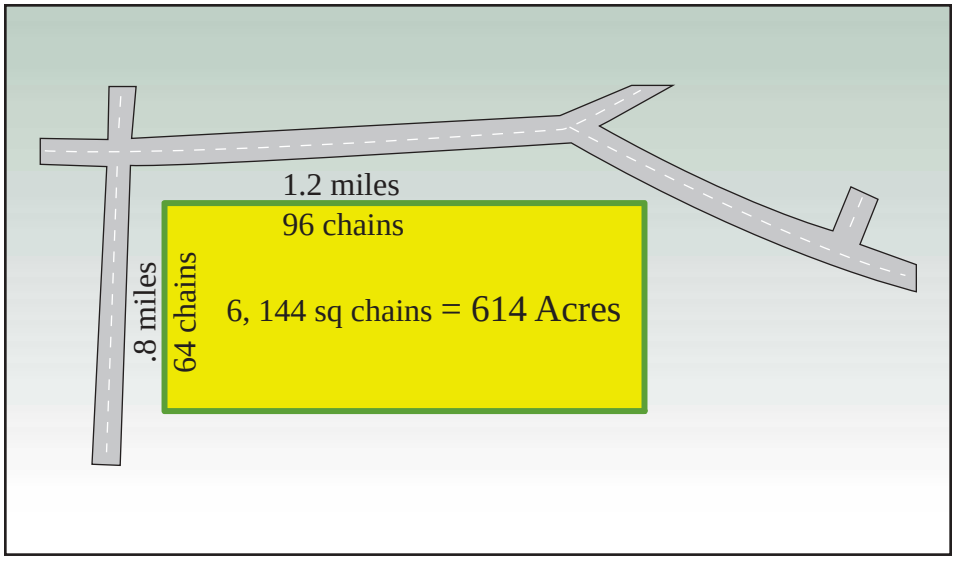

Figure 5

d) Imagine your property is a circle. Pace the radius (r) of the property and use the formula: $A = \pi r^2$ (or, Area equals 3.14 times the radius squared). After getting that area, divide by 10 to get acres.

The next example is for an irregular area, shown in Figure 4. The answer is an approximation but may be close enough for your need. Pace the length A-B. Since the width varies, pace it at two representative points, E-F & C-D. Average those two distances and multiply that times the length. Divide the answer by 10 to produce acres.

The example in Figure 5 may be measured by vehicle. Drive by a large open field. Check the odometer to find it is 1.2 miles long. In our example, you drive another side and measure it as .8 miles long. There are 80 chains to the mile so the lengths now compute to 96 chains and 64 chains. [96ch x 64ch = 6,144 square chains.] Divide that by 10 to get 614 acres. A quick mental check tells us we are correct since one square mile equals 640 acres and our measured area is approximately one square mile.

When traveling a compass direction, whether for just getting to another location or measuring area, think about "directional error" versus "distance." If your line of travel is off by one degree and you travel one mile (80ch or one section), you will miss your target by approximately 92 feet. Accuracy is not only important in direction, but becomes multiplied when used in area computations.

This final paragraph includes additional area information. Figure 6 depicts a *Township* that is 6 miles by 6 miles, or 36 square miles. That is the same as 36 *Sections* of land. The sections are numbered starting at the NE corner in the pattern shown in the example.

Figure 7 divides a square mile/section into 16 equal squares that produce the commonly expressed 40 acres, or an area that is 20ch by 20ch.

Figure 8 includes additional area computations.

Author's Note: Thanks to Robert Wiggins for some of the research included in this article.

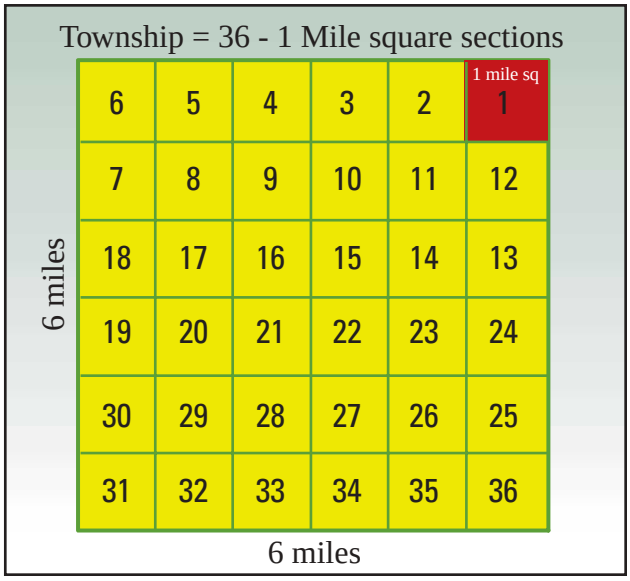

Figure 6

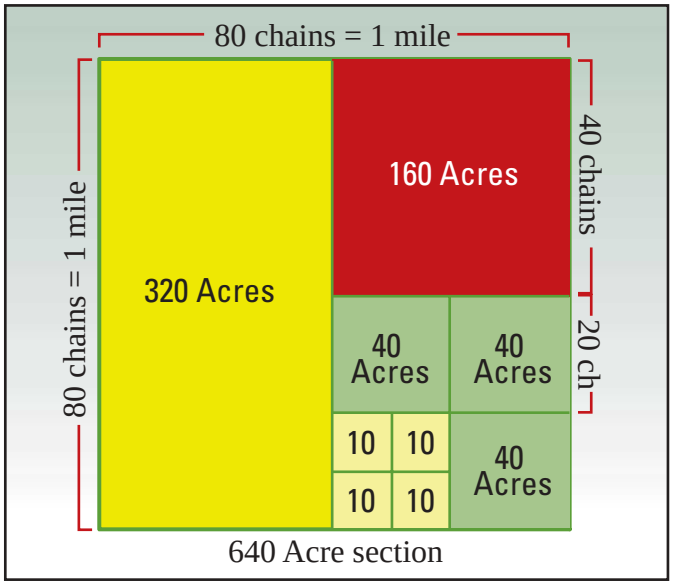

Figure 7

Section

1 mile = 5,280 ft
1 Section = 1 mile x 1 mile
5,280 ft x 5,280 ft = 27,878,400 sq ft
27,878,400 sq ft ÷ 43,560 sq ft/acre = 640 acres

1 mile = 80 chains
80ch x 80ch = 6,400 sq ch
6,400 ÷ 10 sq ch/acre = 640 acres or one section of land

Figure 8
Use the computation that has the most value to you.